FLOOD HAZARD STUDY

LITTLE CALFPASTURE RIVER AND GRASSY RUN

AUGUSTA COUNTY, VIRGINIA

Prepared by

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

In cooperation with
STATE WATER CONTROL BOARD
HEADWATERS SOIL AND WATER CONSERVATION DISTRICT
AUGUSTA COUNTY BOARD OF SUPERVISORS

JUNE 1979

Cover Photo:

Miller Memorial Baptist Church, west of Little Calfpasture River on State Route 811.

United States Department of Agriculture
Soil Conservation Service
P.O. Box 10026
Richmond, Virginia
23240

December 6, 1979

To: All Interested Agencies and Organizations

Enclosed for your information and use is a copy of the recently completed "Flood Hazard Study, Little Calfpasture River and Grassy Run, Augusta County, Virginia." This study was made at the request of the Augusta County Board of Supervisors and Headwaters Soil and Water Conservation District through the State Water Control Board, Bureau of Water Control Management (SWCB). The request was made in accordance with the SWCB's January 1979 Joint Coordination Agreement with the Soil Conservation Service.

This study was carried out under the authority of Section 6 of Public Law 83-566, in accordance with Executive Order 11988, and House Document No. 465, 89th Congress, 2nd Session, especially Recommendation 9(c), "Regulation of Land Use." The purpose of the study is to make flood hazard and land use information available to the local government and citizens in order to encourage land use appropriate to the degree of hazard involved.

The Soil Conservation Service's objective in developing this technical data is to help reduce present and potential flood damages through wise use of flood plain lands, thereby improving the health, safety, economy, and environmental conditions of the community.

Sincerely,

Acting

D. N. Grimwood
State Conservationist

Enclosure

acknowledged
1-2-80
mch

FOREWORD

The Soil Conservation Service, U. S. Department of Agriculture, prepared the information in this flood hazard study report. The Virginia State Water Control Board, the Headwaters Soil and Water Conservation District; and Augusta County cooperated in the development of the report. Augusta County paid the printing and finishing costs for the report.

The flood hazard and land use information should serve as a technical base for flood plain management programs. State and local government, as well as the public, will benefit from increased knowledge of flood hazards on Little Calfpasture River. A program to minimize future flood damages can be developed from this information.

Describing the legal aspects and methods of conducting management programs is not within the scope of this report. However, some general recommendations are included.

We thank the many people who contributed information for the study. We also thank the landowners who gave permission for field surveys and photographs of their land.

TABLE OF CONTENTS

FLOOD HAZARD STUDY
LITTLE CALFPASTURE RIVER -- GRASSY RUN
AUGUSTA COUNTY, VIRGINIA

Introduction

The purpose of this flood hazard study is to define the flood plain and identify potential flood losses. The report will be used to develop and implement a flood plain management program for Little Calfpasture River and Grassy Run, its tributary. Local officials will prescribe and assure compliance with regulations to minimize loss of life and property damage from future floods. Section 872.0 of the Virginia Uniform Statewide Building Code (reference 1) sets certain criteria for construction in flood plains. This study provides data needed to comply with these requirements.

Involved Organizations and Responsibilities

The Headwaters Soil and Water Conservation District (District) and the Augusta County Board of Supervisors (County) applied for the flood hazard study. The State Water Control Board (Board) received the application and requested the Soil Conservation Service (SCS) to conduct this study. SCS prepared a plan of study describing the study area, location, scope, responsibilities, estimated costs, funding arrangements, and tentative schedules. This plan of study was reviewed by the District, County, and Bureau and approved on January 1, 1976.

SCS had responsibility for implementing the technical phases of the study, preparing maps and drawings, and printing the report. The County provided available information on the study area and obtained permission for field surveys. The County also paid all expenses in connection with printing and finishing. The County and District will hold public meetings and provide necessary publicity to implement a flood plain management program. The Board and SCS will provide assistance to assure prompt and effective use of the study findings by the County.

Authorities

The Soil Conservation Service (SCS) of the U. S. Department of Agriculture participated in this study under the following authorities:

Section 6, Public Law 83-566, as amended -- Watershed Protection and Flood Prevention Act of 1954

Recommendation 9(c), House Document No. 465, 89th Congress, 2nd Session

Executive Order 11998, May 24, 1977

U. S. Department of Agriculture Secretary's Memorandums 1606 and 1607, November 7, 1966

Executive Order 11988, January 25, 1978

State statutes and directives of the Governor of Virginia authorize Board, District, and County involvement in flood hazard surveys and related studies. This study was performed in accordance with a Joint Coordination Agreement for Flood Hazard Analyses between the State Water Control Board and the Soil Conservation Service, dated March 1972.

Description of Study Area

Upstream Drainage Area

The Little Calfpasture River drainage area comprises 54.8 square miles above the Rockbridge-Augusta county line (fig. 1). The watershed is part of the Maury River subbasin of the James River. The James River is in the Mid-Atlantic Region, as designated by the Water Resources Council. The USGS Hydrologic Unit code number for the area is 02080202.

The watershed is in the Southern Appalachian Ridges and Valleys physiographic province. Soils are formed primarily from sandstone and shale. Some of the prominent soils are Berks, Hazleton, and Craigsville.1/ Elevations range from about 1,400 feet above sea level to 3,000 feet. Normal annual precipitation is about 40 inches. Normal annual snowfall is 19 inches which is the equivalent of about 1.7 inches of rainfall. The average January temperature is 34 degrees F. and average July temperature is 73 degrees.

Forest occupies about 80 percent of the drainage area. The woodland lies primarily on the steep to very steep slopes of Great North Mountain. About 12 percent, on the more moderate slopes of the valley area, is used for general farming. The Town of Craigsville, the community of Augusta Springs, and other miscellaneous uses comprise about 8 percent of the watershed.

Flood Plains

The main line of the Chesapeake and Ohio Railroad and State Route 42 parallel the Little Calfpasture River, then cross the river and its Grassy Run tributary at the Town of Craigsville. The railroad provided convenient transportation for Craigsville and Augusta Springs, a popular summer resort in the early 1900's. More recently the highway has allowed local residents to commute to jobs and marketing centers in nearby communities. Many residences and commercial structures built along the railroad and highway -- and in the flood plains of these streams -- are still in use.

Land use in the Little Calfpasture River flood plain is about 40 percent cropland, 30 percent idle brushland and woods, and 16 percent pasture. Residences (primarily in Augusta Springs), businesses, farmsteads, and other miscellaneous uses account for the remaining 14 percent. Other than flooding, the principal soil limitation is the cobble and gravelly depositions on much of the idle brushland.

1/ Soil survey data is available at the SCS Augusta County Field Office, Staunton, Virginia.

38°05'
79°17'30"
79°20'
79°22'30"
38°07'30"
38°10'
38°02'30"
79°20'
79°22'30"
79°25'
38°05

N

LEGEND

Watershed boundary

Study area

STAUNTON, VA.
10 MILES

NORTH MOUNTAIN

ESTALINE VALLEY

SMITH CREEK

BROWN RIDGE

CHESAPEAKE AND OHIO RAILROAD

LITTLE CALFPASTURE RIVER

AUGUSTA SPRINGS

STATE ROUTE 42

CRAIGSVILLE

GRASSY RUN

MOTTLEY HOLLOW

STAPLES BRANCH

SULPHUR SPRINGS HOLLOW

SKUPLES HOLLOW

MONTGOMERY RUN

GREAT NORTH MOUNTAIN

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FLOOD HAZARD STUDY AREA VICINITY MAP

LITTLE CALFPASTURE RIVER

AUGUSTA COUNTY, VIRGINIA

SCALE 1:48,000

Figure 1

BASE SOURCE: USGS Topo Quad Sheets 1:24,000

The flood plains of Little Calfpasture River, Grassy Run and short reaches of several small tributaries in Craigsville were studied. These flood plains are all in urban or residential types of development except for several small brushy and wooded areas. Flood flows are restricted and diverted by numerous bridges and culverts.

A total of 12.2 stream miles was studied. This included 8.2 miles of Little Calfpasture River from the Augusta-Rockbridge county line up to Montgomery Run; 1.6 miles of Grassy Run from Little Calfpasture up to the vicinity of State Route 687; 0.7 miles of Staples Hollow from its confluence with Grassy Run up to the Craigsville corporate boundary; 0.7 miles of Sulphur Spring Hollow from Grassy Run up to the town limits; 0.4 miles of Stuples Hollow from Grassy Run to the town limits; and 0.6 miles of Taylor Hollow from Grassy Run up to the town boundary.

Flood History

Major floods on the Little Calfpasture River have been associated with tropical storms. Steep mountains in the area contribute to erratic rainfall patterns. Local residents report that the largest flood on the Little Calfpasture occurred in June 1949. No gage records were available on the streams studied; the estimate of an 80-year frequency was based on several casual recollections as to the depth and extent of flooding. It was estimated that about 320 acres of cropland were inundated and that about 30 homes and other structures suffered slight to severe damage. No lives were lost, but there was one report of children being carried from a school which was surrounded by floodwaters. Similar reports indicate that the second largest flood, in 1955, was much less extensive and damaging than that of 1949.

Flooding on Grassy Run and its tributaries usually has resulted from intense thunderstorm activity. Excess rainfall concentrates quickly on the steep slopes; flood stages rise rapidly and fall just as quickly. Buildings on sites subjected repeatedly to hazardous depths and velocities 2/ have been removed or abandoned; others in less hazardous locations have been partially floodproofed. Flood damage to road fills, businesses and other structures in the flood plains is generally slight to moderate. Long time residents indicated that floods have occurred from early spring to late fall, but in no predictable pattern as to frequency and season. There were no recollections of one particular flood causing unusually severe damage.

Flood Potential

Present Conditions

On the Little Calfpasture River, agricultural damage would accrue on about 360 acres of pasture and cropland during extreme floods. Depths of flooding on these areas would average about two feet, and velocities about three feet per second. Figure 2 shows potential stages of a typical section.

2/ A hazardous condition is considered to exist if: the depth in feet times the velocity in feet per second exceeds seven; or the depth exceeds three feet; or the velocity exceeds 12 feet per second.

Figure 2. Potential flood stages at State Route 683 crossing of Little Calfpasture River.

Figure 3. Potential flood stages at State Route 601 crossing of Little Calfpasture River at Augusta Springs.

The primary potential for flood damage on the Little Calfpasture is to 69 buildings in the flood plain. Forty-nine of the residences are located in Augusta Springs. Nine mobile homes, five small businesses, three barns, and three churches comprise the remainder of these structures. Fortunately, most of the buildings are located on the higher elevations of the flood plain where depths and velocities would be relatively low and slow. Figure 3 illustrates the extent and depths of flooding that can be expected in most of the built-up areas of Augusta Springs and Craigsville. About a dozen buildings would be subjected to hazardous depths and velocities during extreme flood conditions.

In Grassy Run and its tributary flood plains about 73 buildings would be subjected to damage during extreme floods. Most bridge openings and channels have been enlarged or realigned so that flood plain depths of three feet would rarely be exceeded even during the most severe floods. As on the Little Calfpasture, few buildings remain on sites subjected repeatedly to hazardous depths and velocities. Minor damage would be extensive, but severe damage would be limited.

The extent of flooding and type of damage along the streams in the study area are tabulated below. The 100-year and 500-year flood hazard areas are delineated in the photomaps in the appendix.

Stream and type of damage	Acres by flood frequency 100-year	500-year
Little Calfpasture River		
Pasture and cropland	360	330
Idle brushland	192	204
Residential and other miscellaneous	90	96
Subtotal	642	680
Grassy Run and tributaries		
Idle and woodland	11	12
Residential and other miscellaneous	92	102
	103	114
Total	745	794

Future Conditions

No significant change in conditions affecting the rate and volume of flood runoff in the study area is expected within the next 15 to 20 years. Urban type development will continue on a relatively small portion of the upstream drainage area. However, continued progress is expected in controlling runoff and sediment from these developing areas (reference 2). Also, long established conservation programs on agricultural land will continue to off-set the effect of urban development. Implementation of the flood plain management program will prevent or regulate construction or encroachment that might increase the potential for flood damages in the flood plains.

Use of Flood Hazard Exhibits

The technical data needed to prepare and implement the flood plain management program is in the appendix to this report. A procedure is outlined to determine flood elevations at any particular location. An index map shows the study area coverage of individual photomaps.

The 100 and 500-year flood areas and a proposed floodway are shown on flood hazard photomaps prepared from a semi-controlled mosaic. These photomaps should only be used to determine the approximate boundaries of the flood areas and the floodway. Dashed lines indicate reach segments where floodway fringe encroachment inside the 100-year flood line might be allowed.

Flood profile plates provide elevations of the 100-year and 500-year floods at any location along the streams. The elevations and discharges of the 10, 50, 100, and 500-year floods at surveyed cross sections are shown in table A-1. Computed floodway dimensions and surcharge elevations at surveyed cross sections on Little Calfpasture River are shown in table A-2. The procedure, outlined on page A-1, can be used to determine flood profile elevations between cross sections. The minimum height of fill of the floodway fringe (where allowed) can be determined between cross sections by adding the allowable surcharge to the elevation determined for the 100-year flood profile.

Also included in the appendix is a list of benchmark elevations and locations and a glossary of terms. The basic data is on file in the office of the USDA Soil Conservation Service, 400 North Eighth Street, P. O. Box 10026, Richmond, Virginia 23240.

Limitations on Use of Data

The computed data for the floodway (table A-2) should be used only as a guide for further study to determine a designated or regulatory floodway. See additional discussion of the floodway included below in the section on flood plain management with particular reference to Grassy Run and its tributaries.

The flood elevations given in this report should be considered as minimum elevations. During floods, uprooted trees and other debris may collect on bridges and culverts and clog the channels. Such obstructions increase the depth and extent of flooding. Analyses were made without showing the effects of potential obstructions. Also, extremely rare events such as dam failure and climatic changes were not analyzed.

Flood Plain Management

Existing Programs

Augusta County has previously enacted the usual ordinances relating to zoning, subdivisions, sanitation utilities and similar developments. None of the ordinances provide specifically for regulation in the use

and management of flood prone areas, but recent state legislation requires adoption of such regulations by localities. Also, a commitment to such constraints is now a prerequisite for federal funding under certain national programs which provide for assistance to localities to develop and implement flood plain management programs.

An amendment to the Virginia Statewide Building Code, adopted in 1977, (reference 1), imposes restrictions on new construction and flood proofing of existing structures below the 100-year flood elevation. Data in this report can be used to comply with this amendment.

The Virginia Erosion and Sediment Control Handbook (reference 2) was adopted in 1974. The handbook includes criteria for control of runoff and sediment, and for prompt revegetation of sites disturbed by earth-moving operations.

Augusta County has participated in the National Flood Insurance Program since 1974. Participating communities are required to regulate use and development of flood plains The program is administered by the Flood Insurance Administration (FIA) of the Department of Housing and Urban Development (HUD). In those communities participating in the HUD program, owners and occupiers of all buildings and mobile homes in the entire community are eligible to obtain flood insurance coverage. It is recommended that owners and occupants of such structures in or adjacent to the delineated flood hazard areas carry flood insurance on the structures. The bibliography includes several references (3, 4, 5, and 6) which discuss flood plain regulation and flood proofing measures.

Floodway

Encroachment on flood plains reduces the flood-carrying capacity, causes higher flood stages and increases the flood hazard beyond the encroachment itself. This seems to indicate that a simple solution to prevent increased losses from future floods would be to prohibit any additional encroachment or development in flood plains. This solution ignores economic efficiency factors which should be considered in developing a flood plain management program. The floodway concept allows the economic gain from flood plain development to be balanced against the increase in flood hazard.

The floodway is the channel plus any adjacent flood plain areas that must be kept free of encroachment so that the 100-year flood may be carried without substantial increases in flood heights (see fig. 4). HUD standards, accepted in Virginia, limit such increases in flood heights to 1.0 foot provided that hazardous velocities are not produced. A close check of field conditions should be made to assure that the designated floodway is practical and manageable. Considerations other than hazardous velocities may indicate that no encroachment should be allowed on some flood plain reaches. No proposed floodway is shown on Grassy Run and its tributaries. SCS personnel will be available to assist local officials to make a thorough study of the complex field conditions to determine if a manageable floodway can be delineated.

Recommendations

The local sponsors will use the report and other such studies in the country to develop and implement a comprehensive flood plain management program.

It is recommended that the sponsors:

--review and update local ordinances as a sound basis for the program;

--carry out public information activities stressing the need for and the community benefits of the program;

--continue to emphasize the importance of proper land use and conservation treatment in reducing downstream flood hazards;

--encourage owners and occupants of buildings and mobile homes within and adjacent to the delineated flood hazard areas to carry flood insurance on the structures and contents; and,

--examine the feasibility of flood protection for Craigsville and Augusta Springs.

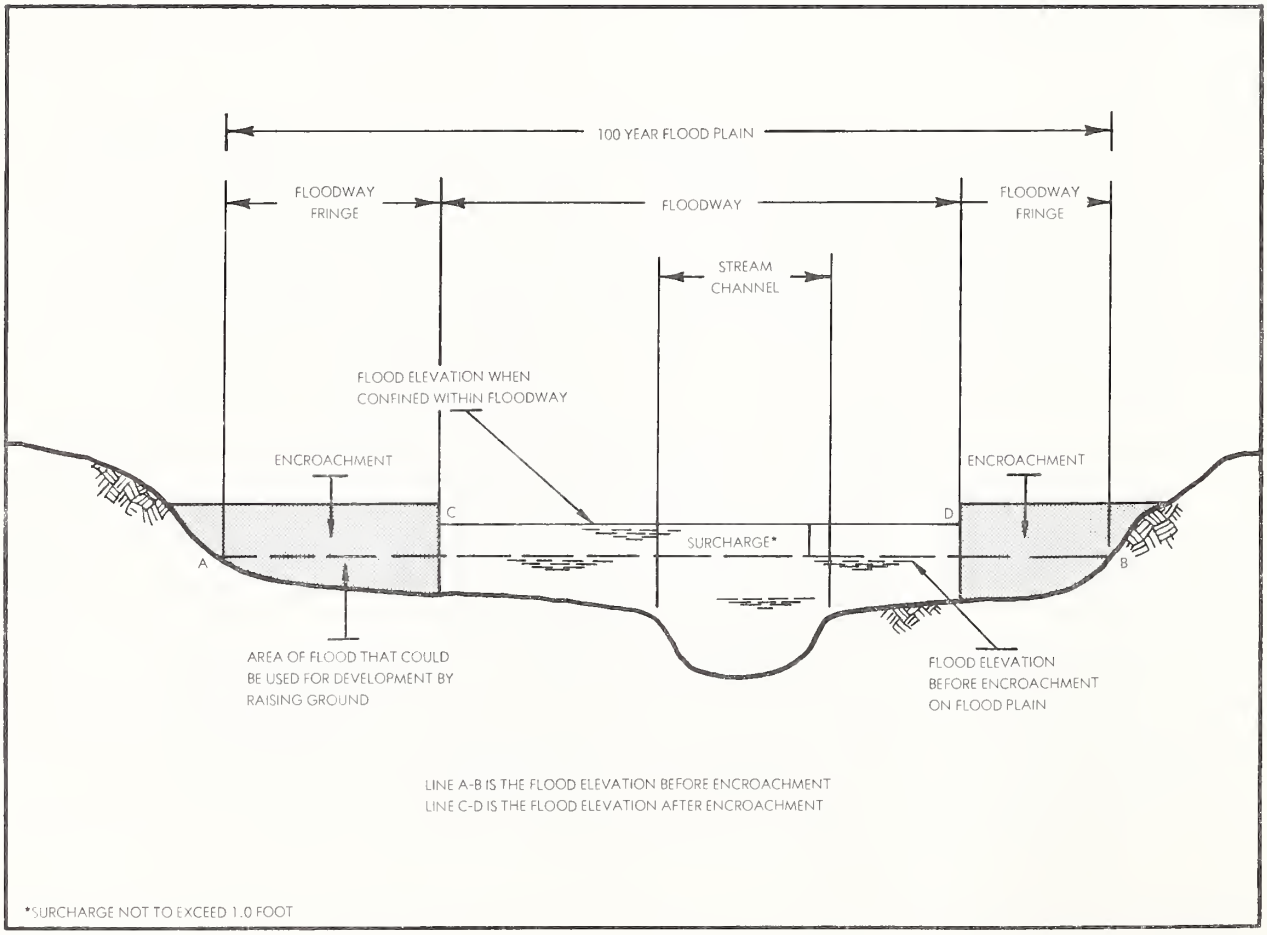


FIGURE 4

FLOODWAY SCHEMATIC

APPENDIX

This appendix provides the data needed to use this report. It is suggested that the reader review the section on Use of Flood Hazard Exhibits in the main body of this report.

The Flood Hazard Area photomaps can be used for decisions where precise elevations are not required; for example, a brief check of the appropriate photomap may indicate that a proposed building site is obviously in (or out) of the flood plain.

Included on the following pages are flood profiles and benchmark data. These two exhibits can be used with the photomaps to determine flood frequency elevations at any point along the streams in the study area, as follows:

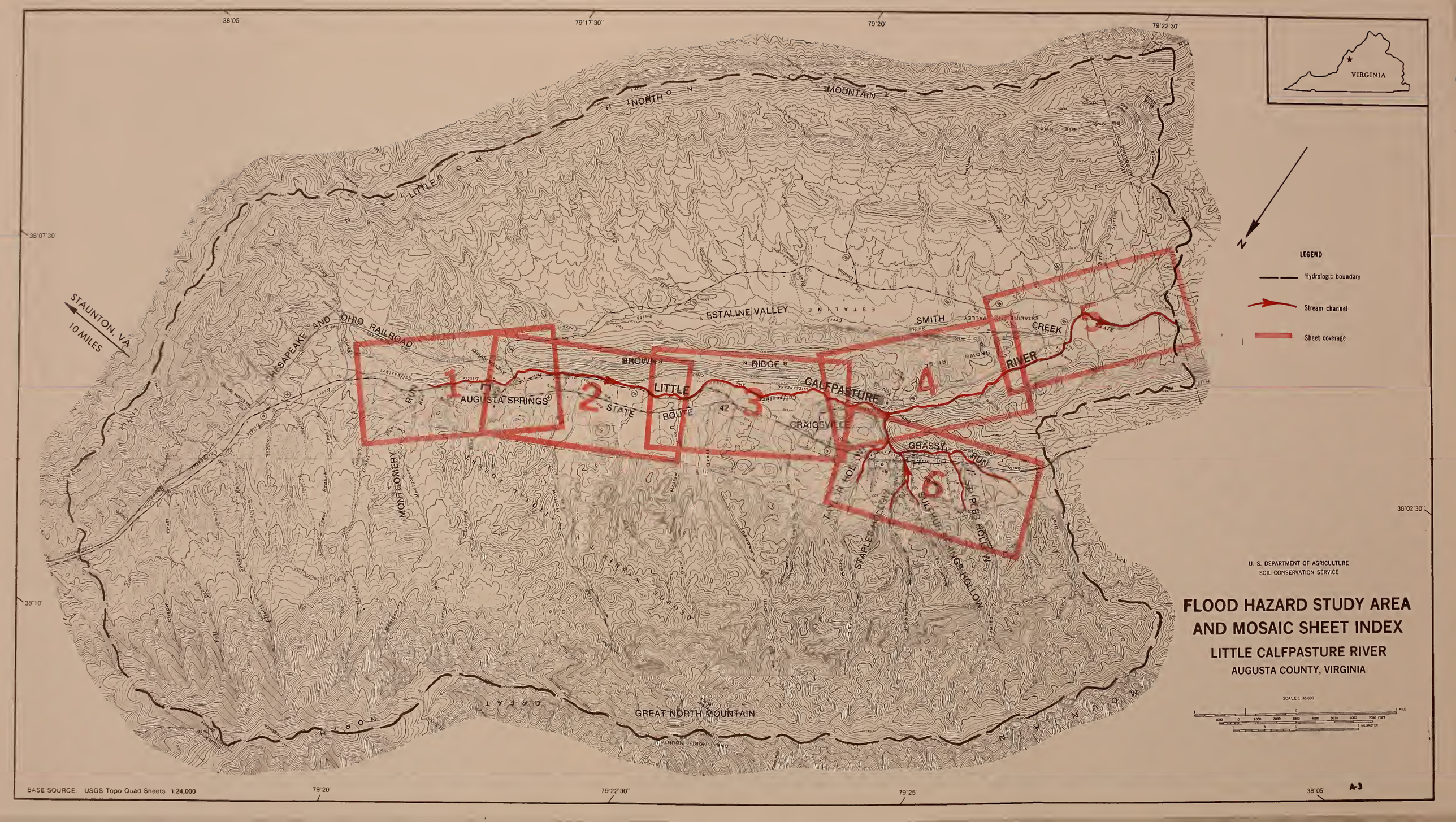
1. From the point on the stream where the flood line is to be located, scale the distance along the stream to the nearest cross section on the appropriate photomap.

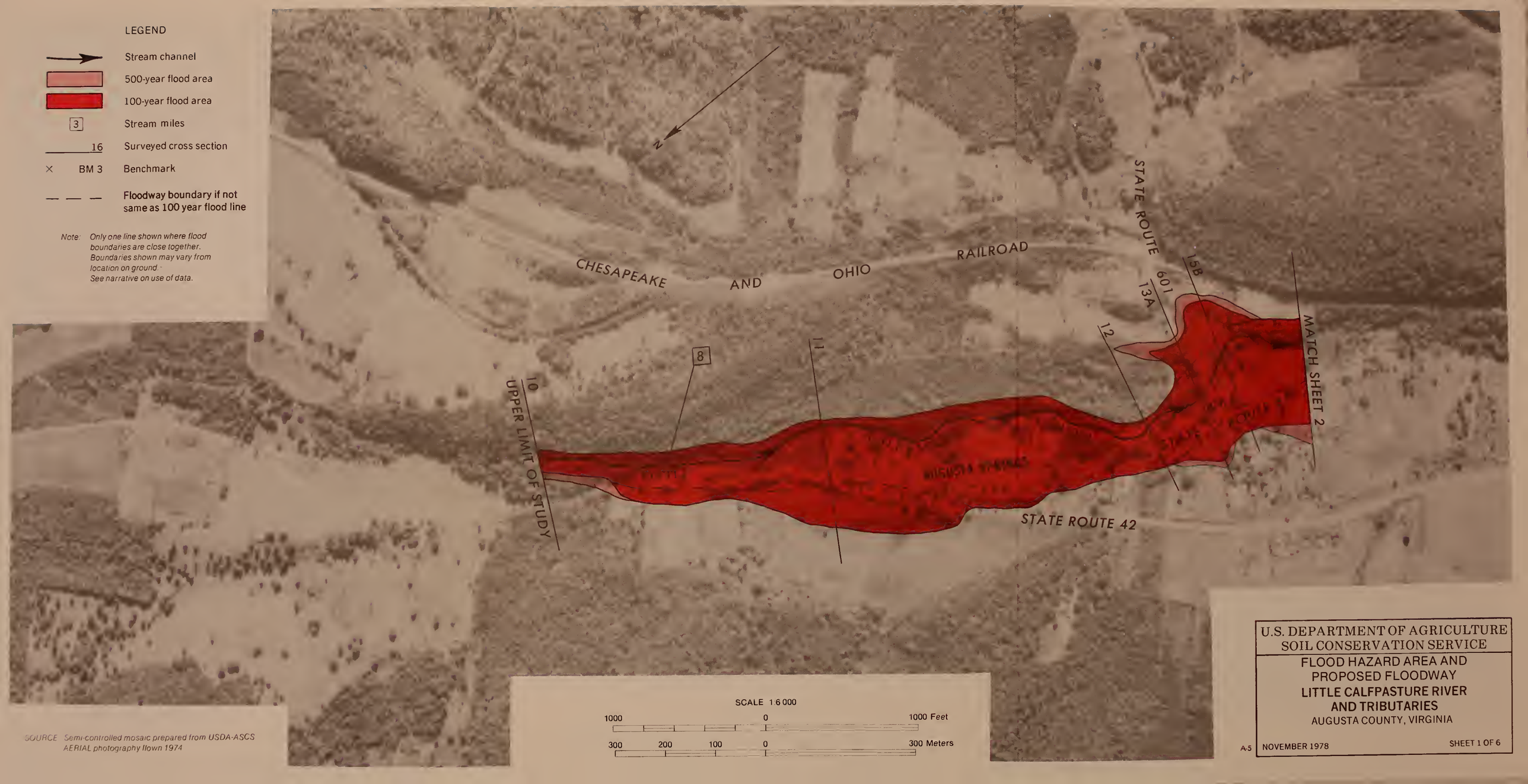
2. Scale the distance determined in Step 1 from the reference cross section back to the original stream station on the appropriate flood profile sheet, and read the elevation of the desired flood frequency line.

3. Transfer the elevation determined in Step 2 to the ground from the nearest established benchmark.

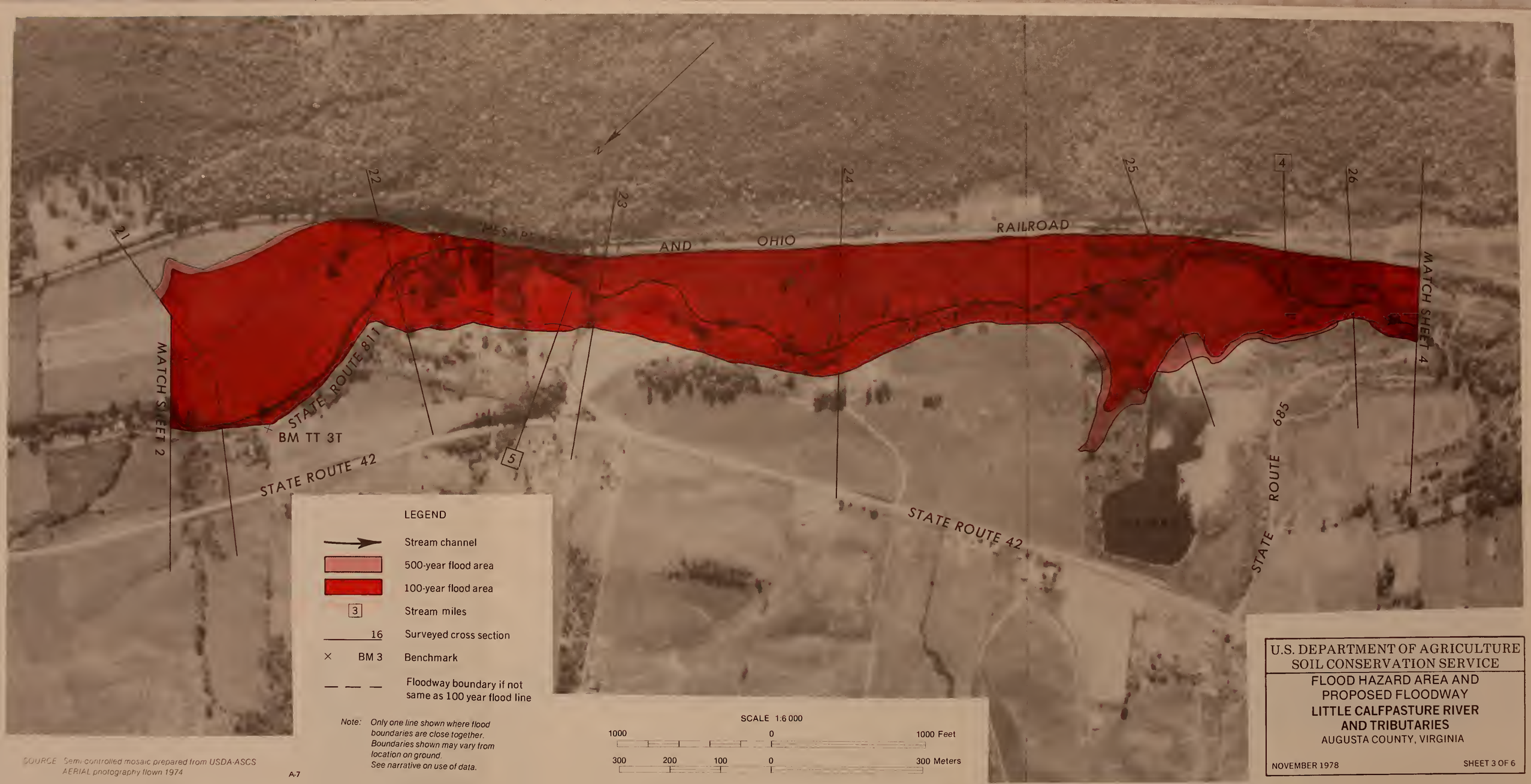
   If the point on the ground is at one of the surveyed cross sections, the elevation can be read directly from Table A-1.

Typical cross sections following the profile plates illustrate the procedure for transposing flood elevations to ground or to flood hazard area photomaps.


38°05'
79°17'30"
79°20'
79°22'30"
38°07'30"
38°02'30"
38°10'
79°20'
79°22'30"
79°25'
38°05'
VIRGINIA
NORTH MOUNTAIN
LITTLE
ESTALINE VALLEY
SMITH CREEK
RIVER
BROWNS RIDGE
CHESAPEAKE AND OHIO RAILROAD
AUGUSTA SPRINGS
LITTLE CALFPASTURE
STATE ROUTE 42
CRAIGSVILLE
GRASSY RUN
MONTGOMERY RUN
TAYLOR HOLLOW
STABLES HOLLOW
SULPHUR SPRINGS HOLLOW
GREAT NORTH MOUNTAIN
STAUNTON, VA.
10 MILES
1
2
3
4
5
6
N
LEGEND
Hydrologic boundary
Stream channel
Sheet coverage
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FLOOD HAZARD STUDY AREA
AND MOSAIC SHEET INDEX
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
SCALE 1:48 000
BASE SOURCE: USGS Topo Quad Sheets 1:24,000
A-3


LEGEND
Stream channel
500-year flood area
100-year flood area
3 Stream miles
16 Surveyed cross section
× BM 3 Benchmark
Floodway boundary if not same as 100 year flood line
Note: Only one line shown where flood boundaries are close together. Boundaries shown may vary from location on ground. See narrative on use of data.
N
CHESAPEAKE AND OHIO RAILROAD
STATE ROUTE 601
13A
15B
12
11
8
10
UPPER LIMIT OF STUDY
MATCH SHEET 2
STATE ROUTE 42
SCALE 1:6 000
1000 0 1000 Feet
300 200 100 0 300 Meters
SOURCE Semi-controlled mosaic prepared from USDA-ASCS AERIAL photography flown 1974
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FLOOD HAZARD AREA AND PROPOSED FLOODWAY
LITTLE CALFPASTURE RIVER AND TRIBUTARIES
AUGUSTA COUNTY, VIRGINIA
A-5 NOVEMBER 1978 SHEET 1 OF 6


LEGEND
Stream channel
500-year flood area
100-year flood area
3 Stream miles
16 Surveyed cross section
× BM 3 Benchmark
Floodway boundary if not same as 100 year flood line
Note: Only one line shown where flood boundaries are close together. Boundaries shown may vary from location on ground. See narrative on use of data.
N
16
17
18
19
6
20
21
7
MATCH SHEET 1
MATCH SHEET 3
STATE ROUTE 42
SCALE 1:6 000
1000 0 1000 Feet
300 200 100 0 300 Meters
SOURCE Semi-controlled mosaic prepared from USDA-ASCS AERIAL photography flown 1974
A-6
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FLOOD HAZARD AREA AND PROPOSED FLOODWAY
LITTLE CALFPASTURE RIVER AND TRIBUTARIES
AUGUSTA COUNTY, VIRGINIA
NOVEMBER 1978
SHEET 2 OF 6



LEGEND

- Stream channel
- 500-year flood area
- 100-year flood area
- 3 — Stream miles
- 16 — Surveyed cross section
- × BM 3 — Benchmark
- Floodway boundary if not same as 100 year flood line

Note: Only one line shown where flood boundaries are close together. Boundaries shown may vary from location on ground. See narrative on use of data.

SCALE 1:6 000

1000 0 1000 Feet

300 200 100 0 300 Meters

SOURCE Semi-controlled mosaic prepared from USDA-ASCS AERIAL photography flown 1974

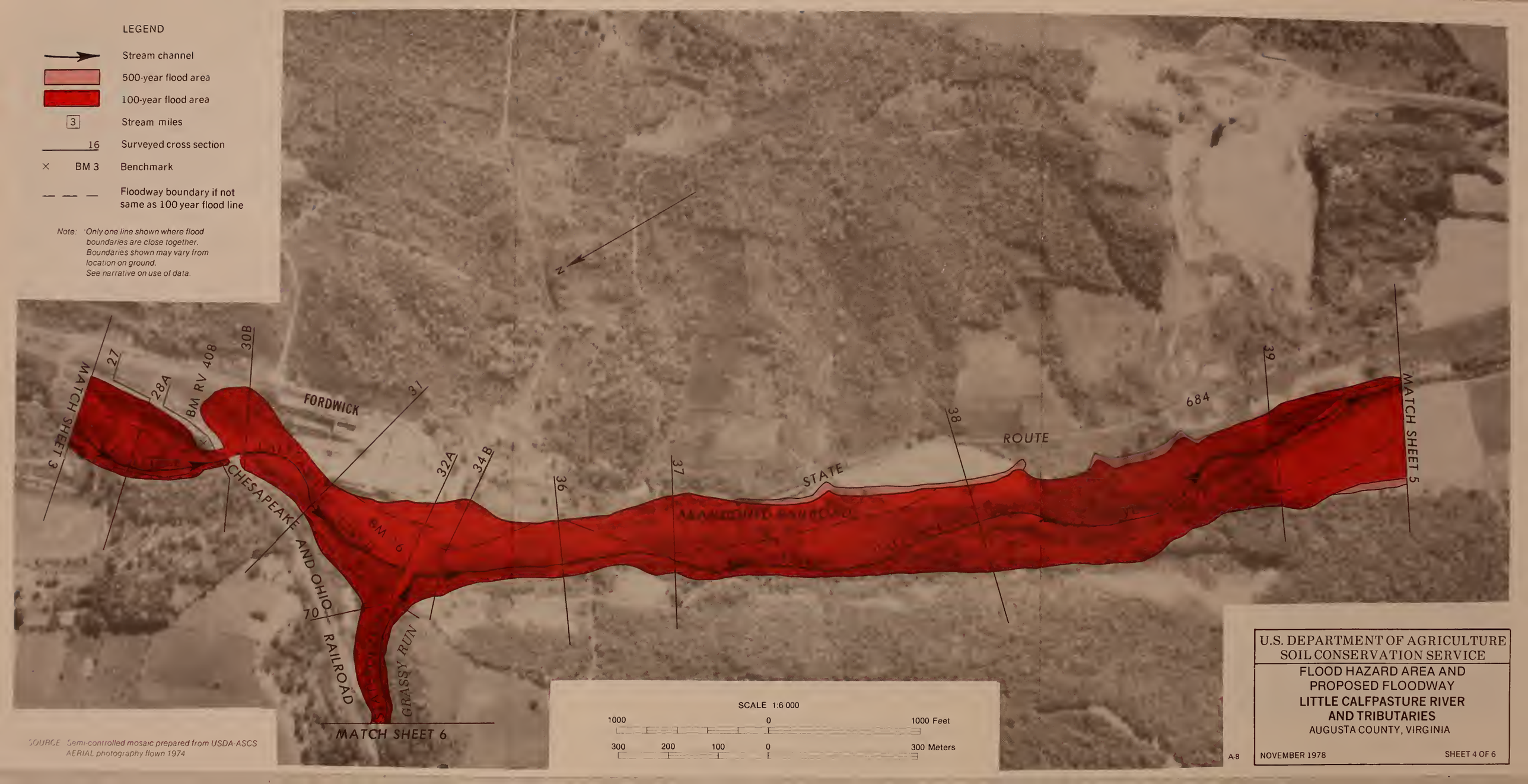
A-7

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FLOOD HAZARD AREA AND PROPOSED FLOODWAY
LITTLE CALFPASTURE RIVER AND TRIBUTARIES
AUGUSTA COUNTY, VIRGINIA

NOVEMBER 1978

SHEET 3 OF 6


LEGEND
Stream channel
500-year flood area
100-year flood area
3 Stream miles
16 Surveyed cross section
× BM 3 Benchmark
Floodway boundary if not same as 100 year flood line
Note: *Only one line shown where flood boundaries are close together. Boundaries shown may vary from location on ground. See narrative on use of data.
N
MATCH SHEET 3
27
28A
BM RV 408
30B
FORDWICK
31
32A
34B
36
37
38
ROUTE
STATE
684
39
MATCH SHEET 5
CHESAPEAKE AND OHIO
70
RAILROAD
BM 6
GRASSY RUN
MATCH SHEET 6
SCALE 1:6 000
1000 0 1000 Feet
300 200 100 0 300 Meters
SOURCE Semi-controlled mosaic prepared from USDA-ASCS AERIAL photography flown 1974
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FLOOD HAZARD AREA AND PROPOSED FLOODWAY
LITTLE CALFPASTURE RIVER AND TRIBUTARIES
AUGUSTA COUNTY, VIRGINIA
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SHEET 4 OF 6
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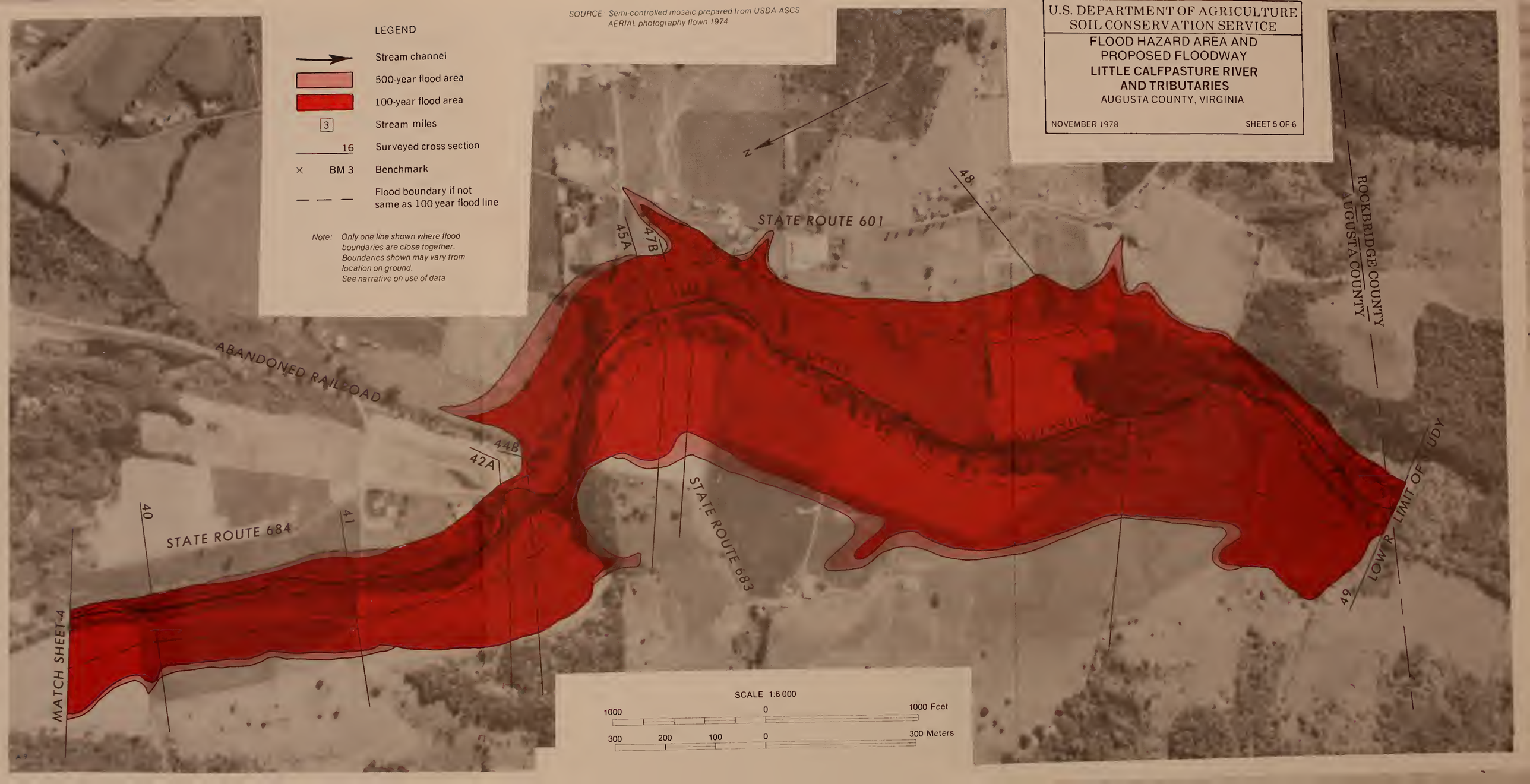
LEGEND
Stream channel
500-year flood area
100-year flood area
3 Stream miles
16 Surveyed cross section
× BM 3 Benchmark
Flood boundary if not same as 100 year flood line
Note: Only one line shown where flood boundaries are close together. Boundaries shown may vary from location on ground. See narrative on use of data
SOURCE: Semi-controlled mosaic prepared from USDA-ASCS AERIAL photography flown 1974
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FLOOD HAZARD AREA AND PROPOSED FLOODWAY
LITTLE CALFPASTURE RIVER AND TRIBUTARIES
AUGUSTA COUNTY, VIRGINIA
NOVEMBER 1978
SHEET 5 OF 6
N
STATE ROUTE 601
ABANDONED RAILROAD
STATE ROUTE 684
STATE ROUTE 683
ROCKBRIDGE COUNTY
AUGUSTA COUNTY
LOWER LIMIT OF STUDY
MATCH SHEET 4
40
41
42A
44B
45A
47B
48
49
SCALE 1:6 000
1000 0 1000 Feet
300 200 100 0 300 Meters

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FLOOD HAZARD AREA AND PROPOSED FLOODWAY LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

NOVEMBER 1978 — SHEET 6 OF 6

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 1 OF 16

SEE PHOTO SHEET 1 & 2

X-SEC-10

UPPER LIMIT OF STUDY

X-SEC-11

X-SEC-12

X-SEC-13A

X-SEC-14 STATE ROUTE 601

X-SEC-15B

X-SEC-16

ELEVATION (FEET NGVD)

1690 1680 1670 1660 1650 1640 1630 1620 1610

435+00 430+00 425+00 420+00 415+00 410+00 405+00 400+00 395+00 390+00 385+00 380+00 375+00 370+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

A-11

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 2 OF 16

SEE PHOTO SHEET 2

X-SEC-16

X-SEC-17

X-SEC-18

X-SEC-19

X-SEC-20

ELEVATION (FEET NGVD)

1630
1620
1610
1600
1590
1580
1570
1560

370+00 365+00 360+00 355+00 350+00 345+00 340+00 335+00 330+00 325+00 320+00 315+00 310+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

A-12

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date

Designed

Drawn MAM 9/78

Traced

Checked

PLATE 3 OF 16

SEE PHOTO SHEET 2 & 3

X-SEC-20

X-SEC-21

X-SEC-22

X-SEC-23

X-SEC-24

ELEVATION (FEET NGVD)

1580

1570

1560

1550

1540

1530

1520

310+00 305+00 300+00 295+00 290+00 285+00 280+00 275+00 270+00 265+00 260+00 255+00 250+00 245+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

A-13

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date
Designed
Drawn MAM 9/78
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Checked

PLATE 4 OF 16

SEE PHOTO SHEET 3 & 4

X-SEC-24

X-SEC-25

X-SEC-26

X-SEC-27

X-SEC-28A

X-SEC-29 CHESAPEAKE & OHIO RAILROAD

X-SEC-30B

X-SEC-31

ELEVATION (FEET NGVD)

1540
1530
1520
1510
1500
1490

245+00 240+00 235+00 230+00 225+00 220+00 215+00 210+00 205+00 200+00 195+00 190+00 185+00 180+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

A-14

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 5 OF 16

SEE PHOTO SHEET 4

X-SEC-32A
X-SEC-33 STATE ROUTE 684
JCT GRASSY RUN
X-SEC-34B
X-SEC-36
X-SEC-37
X-SEC-38
X-SEC-39

ELEVATION (FEET NGVD)

1510
1500
1490
1480
1470
1460

180+00 175+00 170+00 165+00 160+00 155+00 150+00 145+00 140+00 135+00 130+00 125+00 120+00 115+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

A-15

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 6 OF 16

SEE PHOTO SHEET 4 & 5

ELEVATION (FEET NGVD)

1480
1470
1460
1450
1440

X-SEC-39
X-SEC-40
X-SEC-41
X-SEC-42A
X-SEC-43 OLD ABANDONED RAILROAD BRIDGE
X-SEC-44B
X-SEC-45A

115+00 110+00 105+00 100+00 95+00 90+00 85+00 80+00 75+00 70+00 65+00 60+00 55+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 7 OF 16

SEE PHOTO SHEET 5

ELEVATION (FEET NGVD)

1470
1460
1450
1440
1430
1420

X-SEC-45A
X-SEC-46, STATE ROUTE 683
X-SEC-47B
X-SEC-48
X-SEC-49

AUGUSTA COUNTY LINE
ROCKBRIDGE

55+00 50+00 45+00 40+00 35+00 30+00 25+00 20+00 15+00 10+00 5+00 0+00

CHANNEL STATIONS - LITTLE CALFPASTURE RIVER
FEET UPSTREAM FROM THE ROCKBRIDGE & AUGUSTA COUNTY LINE

A-17

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES

LITTLE CALFPASTURE RIVER AND TRIBUTARIES

AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 8 OF 16

SEE PHOTO SHEET 6

X-SEC-55

UPPER LIMIT OF STUDY

X-SEC-56A
X-SEC-57 STATE ROUTE 42
X-SEC-58BA
X-SEC-59 CHESAPEAKE AND OHIO RAILROAD
X-SEC-60B

X-SEC-61A
X-SEC-62 STATE ROUTE 687
X-SEC-63B

JCT STUPLES HOLLOW

ELEVATION (FEET NGVD)

1590
1580
1570
1560
1550
1540
1530

85+00 80+00 75+00 70+00 65+00 60+00 55+00 50+00

CHANNEL STATION - GRASSY RUN
FEET UPSTREAM WITH THE JUNCTION
LITTLE CALFPASTURE RIVER

A-18

FLOOD PROFILES
GRASSY RUN
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 9 OF 16

SEE PHOTO SHEET 6

LEGEND

- 500-YR FLOOD LINE
- 100-YR FLOOD LINE
- APPROX LOW BANK
- CHANNEL BOTTOM
- ELEV-BRIDGE DECK
- ELEV-LOW BEAM
- ELEV-LOW ROAD
- STREAM STATIONING IN MILES (2)

JUNCTION STUPLES HOLLOW X-SEC-64

X-SEC-65

JUNCTION SULPHUR SPRINGS HOLLOW X-SEC-66

JUNCTION TAYLOR HOLLOW X-SEC-67A

X-SEC-68 CHESAPEAKE & OHIO RAILROAD

X-SEC-69B

X-SEC-70

JUNCTION LITTLE CALFPASTURE RIVER

ELEVATION (FEET NGVD)

1560
1550
1540
1530
1520
1510
1500
1490

60+00 55+00 50+00 45+00 40+00 35+00 30+00 25+00 20+00 15+00 10+00 5+00 0+00

CHANNEL STATIONS - GRASSY RUN
FEET UPSTREAM WITH THE JUNCTION
LITTLE CALFPASTURE RIVER

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES (2)

FLOOD PROFILES
STUPLES HOLLOW
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	M.A.M. 9/78
Traced	
Checked	

PLATE 10 OF 16

SEE PHOTO SHEET 6

UPPER LIMIT OF STUDY

X-SEC-81

X-SEC-82A

ELEVATION (FEET NGVD)

1630
1620
1610
1600
1590
1580
1570

38+00 36+00 34+00 32+00 30+00 28+00 26+00 24+00 22+00 20+00 18+00

CHANNEL STATIONS - STUPLES HOLLOW
FEET UPSTREAM FROM THE JUNCTION WITH
GRASSY RUN

A-20

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES
STUPLES HOLLOW
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	M A M 9/78
Traced	
Checked	

PLATE 11 OF 16

SEE PHOTO SHEET 6

X-SEC-82A
X-SEC-83 MADISON STREET CULVERT
X-SEC-84BA
X-SEC-85 POPLAR AVENUE CULVERT
X-SEC-86B
X-SEC-87A
X-SEC-88 STATE ROUTE 42
X-SEC-89AB
X-SEC-90 CHESAPEAKE & OHIO RAILROAD
X-SEC-91B
X-SEC-92A
X-SEC-93 RAILROAD AVENUE
X-SEC-94B
JUNCTION GRASSY RUN

SURFACE OVER CULVERT
CUL TOP
SURFACE OVER CULVERT
CUL TOP
CULVERT BOTTOM
CULVERT BOTTOM

ELEVATION (FEET NGVD)

1590
1580
1570
1560
1550
1540
1530

20+00 18+00 16+00 14+00 12+00 10+00 8+00 6+00 4+00 2+00 0+00

CHANNEL STATIONS - STUPLES HOLLOW
FEET UPSTREAM FROM THE JUNCTION WITH
GRASSY RUN

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES
SULPHUR SPRINGS HOLLOW
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
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PLATE 12 OF 16

SEE PHOTO SHEET 6

X-SEC-101

UPPER LIMIT OF STUDY

JUNCTION STAPLES HOLLOW
X-SEC-102

ELEVATION (FEET NGVD)

1580
1570
1560
1550
1540
1530

36+00 34+00 32+00 30+00 28+00 26+00 24+00 22+00 20+00 18+00 16+00 14+00

CHANNEL STATIONS - SULPHUR SPRINGS HOLLOW
FEET UPSTREAM FROM THE JUNCTION WITH GRASSY RUN

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV - BRIDGE DECK

ELEV - LOW BEAM

ELEV - LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES
SULPHUR SPRINGS HOLLOW TRIBUTARY OF LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
Traced	
Checked	

PLATE 13 OF 16

SEE PHOTO SHEET 6

ELEVATION (FEET NGVD)

1560
1550
1540
1530
1520
1510

X-SEC-102
X-SEC-103A
X-SEC-104 STATE ROUTE 687
X-SEC-105B
X-SEC-106A
X-SEC-107 STATE ROUTE 42
X-SEC-108B
X-SEC-109
JUNCTION GRASSY RUN

18+00 16+00 14+00 12+00 10+00 8+00 6+00 4+00 2+00 0+00

CHANNEL STATIONS - SULPHUR SPRINGS HOLLOW
FEET UPSTREAM FROM THE JUNCTION WITH GRASSY RUN

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES
STAPLES HOLLOW
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	M A M 9/78
Traced	
Checked	

PLATE 14 OF 16

SEE PHOTO SHEET 6

X-SEC-112

X-SEC-113

ELEVATION (FEET NGVD)

1590
1580
1570
1560
1550
1540
1530

26+00 24+00 22+00 20+00 18+00 16+00 14+00 12+00 10+00 8+00 6+00 4+00 2+00 0+00

CHANNEL STATIONS - STAPLES HOLLOW
FEET ABOVE MOUTH WITH THE JUNCTION
SULPHUR SPRINGS HOLLOW

JUNCTION SULPHUR SPRINGS HOLLOW

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES 2

FLOOD PROFILES
TAYLOR HOLLOW
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	MAM 9/78
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Checked	

PLATE 15 OF 16

SEE PHOTO SHEET 6

ELEVATION (FEET NGVD)

1600
1590
1580
1570
1560
1550

UPPER LIMIT OF STUDY

X-SEC-121

X-SEC-122

40+00 38+00 36+00 34+00 32+00 30+00 28+00 26+00

CHANNEL STATIONS - TAYLOR HOLLOW
FEET UPSTREAM FROM THE JUNCTION
WITH GRASSY RUN

LEGEND

500-YR FLOOD LINE

100-YR FLOOD LINE

APPROX LOW BANK

CHANNEL BOTTOM

ELEV-BRIDGE DECK

ELEV-LOW BEAM

ELEV-LOW ROAD

STREAM STATIONING IN MILES

FLOOD PROFILES
TAYLOR HOLLOW
TRIBUTARY OF
LITTLE CALFPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Date
Designed
Drawn MAM 9/78
Traced
Checked

PLATE 16 OF 16
SEE PHOTO SHEET 6

X-SEC-122
X-SEC-123A
X-SEC-124 STATE ROUTE 42
X-SEC-125B
X-SEC-126A
X-SEC-127 RAILROAD AVENUE
X-SEC-128B
X-SEC-129
JUNCTION GRASSY RUN

ELEVATION (FEET NGVD)

1570
1560
1550
1540
1530
1520
1510
1500

26+00 24+00 22+00 20+00 18+00 16+00 14+00 12+00 10+00 8+00 6+00 4+00 2+00 0+00

CHANNEL STATIONS - TAYLOR HOLLOW
FEET UPSTREAM FROM THE JUNCTION
WITH GRASSY RUN

A-26

TYPICAL CROSS SECTIONS
FLOOD HAZARD ANALYSES
LITTLE CALPASTURE RIVER
AUGUSTA COUNTY, VIRGINIA

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date
Designed	
Drawn	M A M 10/78
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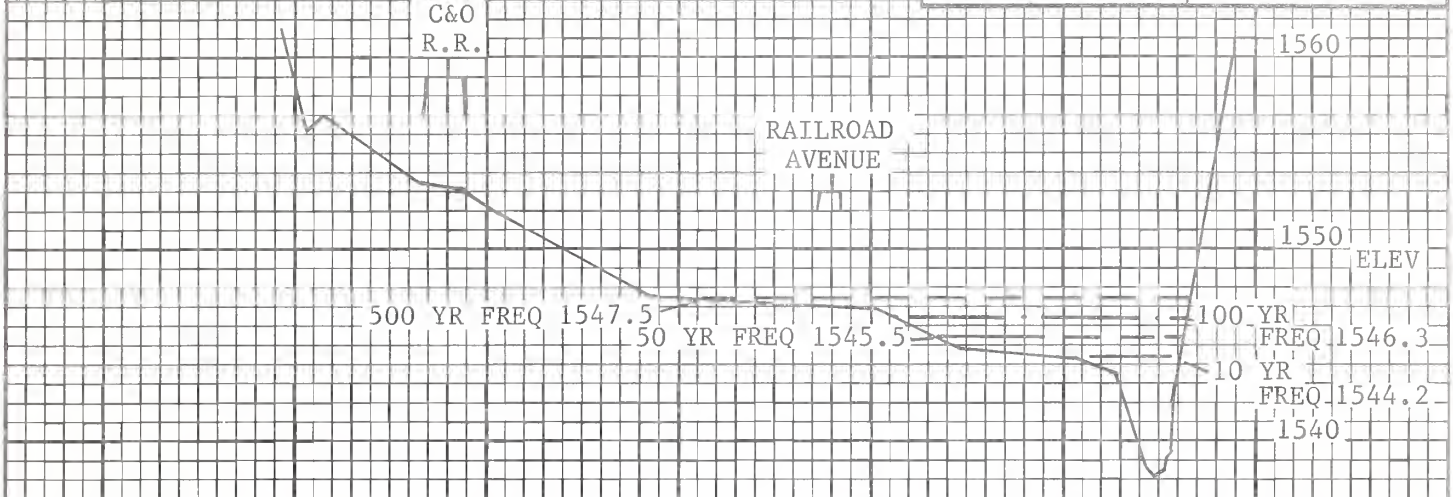
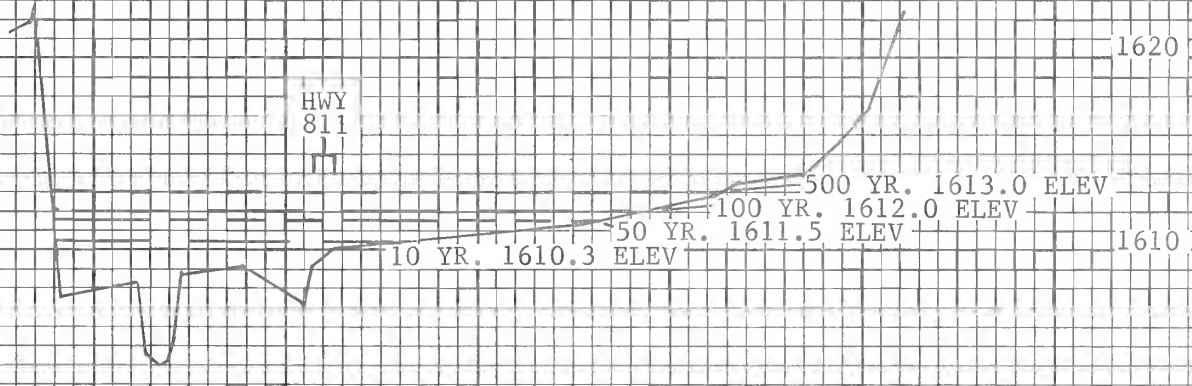


GRASSY RUN CROSS SECTION 64
TRIBUTARY OF LITTLE CALFPASTURE RIVER



ELEVATION (FEET NGVD)

LITTLE CALFPASTURE RIVER - CROSS SECTION 17
HORIZONTAL STATIONING (IN FEET)

Table A-1 Frequency-discharge-elevations at surveyed cross sections on Little Calfpasture River, Augusta County, Virginia.

X-Sec.	Photo Map No.	Profile Plate No.	10-year Disch. (cfs)	10-year Elev. (msl)	50-year Disch. (cfs)	50-year Elev. (msl)	100-year Disch. (cfs)	100-year Elev. (msl)	500-year Disch. (cfs)	500-year Elev. (msl)
Little Calfpasture River - upper limit of study										
10	1	1	2450	1682.0	4150	1684.7	5200	1685.6	7800	1687.0
11	1	1	2490	1660.2	4240	1661.1	5300	1661.5	7900	1662.2
12	1	1	2700	1634.0	4650	1635.0	5800	1635.6	8750	1636.6
13A	1	1	2960	1631.6	5100	1632.8	6300	1633.2	9600	1634.0
State Route 601, low road 1629.5, L.S. 1629.7, top bridge deck 1631.0										
15B	1	1	2970	1630.4	5150	1631.3	6350	1631.5	9650	1632.4
16	2	1 & 2	3010	1620.8	5215	1621.8	6425	1622.2	9725	1623.0
17	2	2	3050	1610.3	5280	1611.5	6500	1612.0	9800	1613.0
18	2	2	3650	1598.3	6400	1600.2	7800	1600.6	11600	1601.6
19	2	2	3690	1586.8	6440	1588.0	7900	1589.0	11800	1590.0
20	2	2 & 3	3940	1572.2	6950	1573.2	8450	1573.5	12600	1574.2
21	3	3	4000	1559.5	7100	1560.4	8650	1560.7	12800	1561.5
22	3	3	4120	1551.5	7300	1552.7	8900	1553.4	13100	1554.4
23	3	3	4400	1542.0	7790	1543.6	9400	1544.2	13900	1545.5
24	3	3 & 4	4420	1533.0	7800	1534.7	9450	1535.3	14000	1536.5
25	3	4	4550	1522.4	8000	1523.7	9800	1524.4	14600	1526.1
26	3	4	4560	1514.0	8120	1516.0	9840	1516.9	14640	1519.0
27	4	4	4580	1510.3	8140	1512.6	9880	1513.4	14680	1515.6
28A	4	4	4590	1507.5	8150	1510.1	9920	1510.7	14720	1512.5
C&O Railroad, low road 1522.5, L.S. 1521.1, top bridge deck 1524.0										
30B	4	4	4595	1506.4	8180	1508.5	9960	1509.2	14760	1511.4
31	4	4 & 5	4630	1503.6	8190	1505.5	9980	1506.2	14780	1508.0
32A	4	5	4650	1500.2	8200	1502.3	10000	1503.0	14800	1505.0
State Route 684, low road 1499.0, L.S. 1501.6, top bridge deck 1504.9										
34B	4	5	5700	1499.3	10000	1501.3	12000	1502.0	18000	1504.0
36	4	5	5710	1494.4	10010	1497.4	12010	1498.5	18070	1500.9
37	4	5	5730	1491.9	10030	1494.7	12030	1495.9	18130	1498.1
38	4	5	5750	1485.3	10050	1488.0	12050	1488.8	18200	1490.7
39	4	5 & 6	5760	1475.5	10060	1477.2	12060	1477.8	18250	1479.5

Continued

Table A-1 Frequency-discharge-elevations at surveyed cross sections on Little Calfpasture River, Augusta County, Virginia--Continued

X-Sec.	Photo Map No.	Profile Plate No.	10-year Disch. (cfs)	10-year Elev. (msl)	50-year Disch. (cfs)	50-year Elev. (msl)	100-year Disch. (cfs)	100-year Elev. (msl)	500-year Disch. (cfs)	500-year Elev. (msl)
40	5	6	5780	1471.1	10080	1473.0	12080	1473.6	18300	1475.3
41	5	6	5790	1467.0	10090	1468.6	12090	1469.3	18350	1470.5
42A	5	6	5800	1462.4	10100	1463.7	12100	1464.3	18400	1465.3
	Abandoned Railroad, low road 1459.9, L.S. 1461.5, top bridge deck 1463.5									
44B	5	6	5800	1461.5	10100	1462.6	12100	1463.1	18400	1464.0
45A	5	6 & 7	7150	1455.3	12500	1456.9	15400	1457.5	23250	1458.9
	State Route 683, low road 1450.6, L.S. 1454.5, top bridge deck 1455.5									
47B	5	7	7200	1454.7	12550	1456.3	15450	1456.9	23300	1458.3
48	5	7	7400	1445.7	12980	1447.4	15970	1448.2	24150	1450.3
49	5	7	7600	1439.7	13400	1442.7	16500	1444.1	25000	1447.1
Grassy Run - upper limit of study										
55	6	8	440	1585.4	780	1586.0	960	1586.3	1450	1586.9
56A	6	8	470	1568.5	840	1569.6	1025	1570.3	1530	1571.7
	State Route 42, low road 1572.5, L.S. 1569.9, top bridge deck 1572.5									
58BA	6	8	475	1567.2	845	1567.8	1030	1568.1	1540	1568.6
	C&O Railroad, low road 1565.0, L.S. 1572.1, top bridge deck 1575.3									
60B	6	8	480	1565.3	855	1566.1	1040	1566.4	1550	1567.1
61A	6	8	540	1555.6	930	1556.4	1140	1556.6	1670	1557.0
	State Route 687, low road 1553.7, L.S. 1554.9, top bridge deck 1556.3									
63B	6	8	550	1554.3	950	1554.8	1160	1555.1	1700	1555.6
64	6	9	1000	1544.2	1700	1545.5	2100	1546.3	3200	1547.5
65	6	9	1000	1529.0	1700	1530.3	2100	1530.7	3200	1532.0
66	6	9	1350	1517.3	2400	1518.7	2900	1519.3	4400	1520.5
67A	6	9	1750	1510.0	3050	1512.4	3750	1513.5	5600	1516.0
	C&O Railroad, low road 1525.1, L.S. 1521.7, top bridge deck 1527.4									
69B	6	9	1750	1508.4	3050	1510.1	3750	1510.9	5600	1512.7
70	6	9	1760	1500.3	3060	1501.9	3800	1502.7	5650	1504.6

Continued

Table A-1 Frequency-discharge-elevations at surveyed cross sections on Little Calfpasture River, Augusta County, Virginia--Continued

X-Sec.	Photo Map No.	Profile Plate No.	10-year Disch. (cfs)	10-year Elev. (msl)	50-year Disch. (cfs)	50-year Elev. (msl)	100-year Disch. (cfs)	100-year Elev. (msl)	500-year Disch. (cfs)	500-year Elev. (msl)
Taylor Hollow - upper limit of study										
121	6	15	275	1595.4	495	1595.9	610	1596.4	940	1597.1
122	6	15 & 16	310	1559.4	490	1559.7	680	1560.2	1040	1560.6
123A	6	16	330	1540.1	520	1540.4	720	1540.6	1095	1540.9
	State Route 42, low road 1539.5, L.S. 1540.5, top bridge deck 1542.7									
125B	6	16	335	1538.1	525	1538.5	730	1538.8	1100	1539.2
126A	6	16	335	1529.6	525	1530.0	730	1530.3	1100	1530.6
127	Railroad Avenue, low road 1527.8, L.S. 1529.2, top bridge deck 1531.3									
128B	6	16	340	1528.3	530	1528.7	740	1529.2	1200	1529.5
129	6	16	420	1510.4	740	1512.4	890	1513.1	1320	1515.3
Stuples Hollow - upper limit of study										
81	6	10	370	1634.7	670	1635.4	820	1535.5	1210	1636.2
82A	6	10	400	1582.5	705	1583.1	870	1583.4	1290	1583.9
	Madison Street, low road 1581.6, top of culvert 1582.8									
84BA	6	11	400	1580.2	705	1580.9	870	1581.2	1290	1581.9
	Poplar Avenue, low road 1581.6, top of culvert 1579.2									
86B	6	11	405	1576.5	710	1577.4	875	1577.6	1295	1578.4
87A	6	11	410	1556.7	720	1557.6	880	1558.0	1305	1558.9
	State Route 42, low road 1559.2, L.S. 1555.1, top bridge deck 1557.3									
89BA	6	11	410	1553.7	720	1554.7	880	1555.0	1310	1555.7
	C&O Railroad, low road 1553.6, L.S. 1552.6, top bridge deck 1555.6									
91B	6	11	410	1549.6	720	1550.5	880	1550.7	1310	1551.2
92A	6	11	410	1547.0	720	1547.6	880	1547.9	1310	1548.9
	Railroad Avenue, low road 1545.7, L.S. 1545.8, top bridge deck 1548.3									
94B	6	11	410	1545.0	720	1545.4	880	1547.0	1310	1548.5

Continued

Table A-1 Frequency-discharge-elevations at surveyed cross sections on Little Calfpasture River, Augusta County, Virginia--Continued

X-Sec.	Photo Map No.	Profile Plate No.	10-year Disch. (cfs)	10-year Elev. (msl)	50-year Disch. (cfs)	50-year Elev. (msl)	100-year Disch. (cfs)	100-year Elev. (msl)	500-year Disch. (cfs)	500-year Elev. (msl)
Sulphur Springs Hollow - upper limit of study										
101	6	12	250	1579.3	455	1580.1	560	1580.4	860	1581.0
102	6	12 & 13	410	1536.2	720	1537.0	890	1537.4	1310	1538.3
103A	6	13	410	1529.1	720	1530.5	890	1530.7	1310	1531.3
State Route 687, low road 1530.0, L.S. 1529.4, top bridge deck 1530.5										
105B	6	13	410	1527.5	720	1528.2	890	1528.5	1310	1522.8
State Route 42, low road 1521.0, S.S. 1520.7, top bridge deck 1523.0										
108B	6	13	410	1520.5	720	1520.9	890	1521.3	1310	1521.9
109	6	13	410	1517.9	720	1519.0	890	1519.5	1310	1520.6
Staples Hollow - upper limit of study										
112	6	14	170	1593.4	305	1593.9	375	1594.0	560	1594.5
113	6	14	220	1558.3	385	1558.8	470	1559.2	720	1559.5

Table A-2 Floodway data, Little Calfpasture River--Grassy Run Flood Hazard Study, Augusta County, Virginia.

Flooding Source		Floodway			Base Flood Water Surface Elevation		
Cross Section	Distance[1] (Ft.)	Width (Ft.)	Section Area (Sq. Ft.)	Mean Velocity (F.P.S.)	With Floodway (NGVD)	Without Floodway (NGVD)	Difference (Ft.)
Little Calfpasture River							
10	43,155	155	580	9.0	1685.6	1685.6	0.0[2]
11	41,210	405	890	6.0	1662.5	1661.5	1.0
12	38,925	345	900	6.3	1635.6	1635.6	0.0[2]
13A	38,515	436	1,820	3.4	1634.2	1633.2	1.0
15B	38,205	495	1,780	3.6	1632.5	1631.5	1.0
16	37,085	310	1,250	5.1	1623.2	1622.2	1.0
17	35,775	198	1,050	6.2	1613.0	1612.0	1.0
18	34,465	527	1,560	5.0	1600.6	1600.6	0.0[2]
19	32,800	566	1,380	5.7	1589.0	1589.0	0.0[2]
20	30,975	382	1,480	5.7	1574.5	1573.5	1.0
21	29,200	504	2,050	4.2	1561.7	1560.7	1.0
22	27,625	412	1,970	4.5	1554.4	1553.4	1.0
23	26,175	454	1,610	5.8	1544.2	1544.2	0.0[2]
24	24,425	847	2,040	4.6	1535.3	1535.3	0.0[2]
25	22,155	498	2,610	3.7	1525.4	1524.4	1.0
26	20,635	215	1,950	5.1	1517.9	1516.9	1.0
27	19,710	291	2,010	4.9	1514.4	1513.4	1.0
28A	19,095	122	1,160	8.6	1510.7	1510.7	0.0[2]
30B	18,935	527	1,600	6.2	1509.2	1509.2	0.0[2]
31	18,370	279	1,560	6.4	1506.2	1506.2	0.0[2]
32A	17,600	429	2,470	4.0	1504.0	1503.0	1.0
34B	17,390	319	1,960	6.1	1503.0	1502.0	1.0
36	16,550	316	1,940	6.2	1498.5	1498.5	0.0[2]
37	15,805	128	1,630	7.4	1496.9	1495.9	1.0

Continued

Table A-2 Floodway data, Little Calfpasture River--Grassy Run Flood Hazard Study, Augusta County, Virginia--Continued.

Flooding Source		Floodway			Base Flood Water Surface Elevation		
Cross Section	Distance[1/] (Ft.)	Width (Ft.)	Section Area (Sq. Ft.)	Mean Velocity (F.P.S.)	With Floodway (NGVD)	Without Floodway (NGVD)	Difference (Ft.)
Little Calfpasture River (continued)							
38	13,740	596	2,130	5.6	1488.8	1488.8	0.0[2/]
39	11,480	473	2,870	4.2	1478.8	1477.8	1.0
40	9,920	250	2,000	6.0	1474.6	1473.6	1.0
41	8,595	279	1,920	6.3	1470.3	1469.3	1.0
42A	7,335	537	2,870	4.2	1465.3	1464.3	1.0
44B	7,140	502	2,630	4.6	1464.1	1463.1	1.0
45A	5,530	498	3,780	4.1	1458.5	1457.5	1.0
47B	5,365	399	2,960	5.2	1457.9	1456.9	1.0
48	2,100	1,058	4,800	3.3	1449.2	1448.2	1.0
49	0	255	3,110	5.3	1445.1	1444.1	1.0

1/ Distance in feet above Rockbridge-Augusta county line.
2/ Encroachment would cause excessive velocities.

Continued

Investigations and Analyses

The essential data required for this report were obtained from flood profiles developed for selected frequencies through the study area. Elevations from the flood profiles were transposed to the photomaps to outline the flood area limits. Technical procedures used are outlined in section 4 of the SCS National Engineering Handbook and other standard guides and texts.

Approximately 100 cross sections and 12 miles of bench levels were surveyed. Surveys are referenced to mean sea level elevation, National Geodetic Vertical Datum of 1929. Elevation reference marks (BM) are listed in table A-3 and shown on appropriate photomaps. Stage-discharge at surveyed cross sections was determined using the SCS computer program, WSP2 (reference 7).

The SCS TR-20 flood routing program was used to determine frequency discharge in the study area (reference 8). This procedure involved routing the runoff from a 24-hour rainfall for the selected frequency as published in U. S. Weather Bureau Technical Paper 40: 10-year, 5.1 inches; 50-year, 6.55 inches; 100-year, 7.2 inches; and 500-year (extrapolated), 8.5 inches. Estimates of rainfall-runoff factors were based on present land use conditions. The computed data was checked for reliability from analysis of the stream gage data in the general area. The U. S. Geological Survey (USGS) furnished their Water Resources Council Bulletin 17A analyses of these gages (reference 9). The USGS application of these procedures was discussed with them and used to make moderate adjustments in the TR-20 data.

Typical valley cross sections on page A-27 illustrate how flood profile elevations were transposed to flood area maps. Flood area boundaries were interpolated between surveyed cross sections and checked in the field.

The proposed floodway data was computed on the basis of equal conveyance reduction from each side of the flood plain. Encroachment was not proposed where hazardous velocities would be produced. Further studies are also suggested where other unmanageable conditions may result.

Table A-3 Benchmark descriptions, locations and elevations, Little Calfpasture River, Augusta County, Virginia

BM No.	Photo Map No.	Description, location and elevation
4	1	SCS TBM - An aluminum disk is in the base of power pole No. 89 at intersection of State Route 811 and 601 at Augusta Springs, Virginia. Elevation 1630.50
7	2	SCS TBM - A square is chiseled on top of guard rail on the downstream (southeast) corner of concrete bridge on State Route 811 in front of Miller Memorial Church. Elevation 1602.89
TT3T	3	USC&GS BM - 1.7 miles southwest of Augusta Springs along State Route 811 to junction with dirt road, 17 feet southwest of dirt road, at fence line in concrete post, a standard tablet stamped "TT3T 1942 1567." Elevation 1566.60
12	3	SCS TBM - A square is chiseled on concrete base of signal box on the west side of Chesapeake & Ohio Railroad, approximately 80 feet north near cross section 24 at farm lane across railroad track. Elevation 1539.65
RV408	4	USC&GS BM - At Fordwick, Augusta County, approximately 225 yards west of the Chesapeake & Ohio Railway station at bridge No. 2431 over Little Calfpasture River and State Route 685, in top of the south end of a concrete back wall. A standard Monel-metal rivet. Elevation 1515.72
16	4	SCS TBM - A square chiseled on the upstream corner of the abutment of concrete bridge at State Route 684 crossing of the Little Calfpasture River, northwest of an abandoned cement plant. Elevation 1504.86
T-159	5	USC&GS BM - Approximately 2.1 miles southwest along State Route 684 from the post office at Fordwick, Augusta County, approximately 2.7 miles southwest of Estaline School, at the crossing of the Fordwick Cement Company Railroad over Little Calfpasture River in top of the west end of the abutment, and 85 feet northwest of State Route 684, near Little River Church. A standard disk stamped "T-159 1935." Elevation 1462.84
22	5	SCS TBM - A square is chiseled on the downstream southeast abutment of a steel bridge over Little Calfpasture River on State Route 683. Elevation 1454.75

Continued

Table A-3 Benchmark descriptions, locations and elevations, Little Calfpasture River, Augusta County, Virginia

BM No.	Photo Map No.	Description, location and elevation
Along Grassy Run and tributaries		
27	6	SCS TBM - A square is chiseled on the downstream end of concrete bridge over Grassy Run on State Route 42, west of Craigsville, Augusta County, Virginia. Elevation 1572.50
35	6	SCS TBM - A square is chiseled on the southwest corner of bridge on the downstream side at crossing of State Route 42 over Sulphur Spring Hollow. Elevation 1523.13
36	6	VDH BM - 0.5 mile northeast of Chesapeake & Ohio Railroad station along Railroad Avenue to intersection with State Route 42, a chiseled square is on center of concrete base of stop sign. Elevation 1543.84
44	6	SCS TBM - A square is chiseled on the retaining wall on the upstream (northwest) corner of bridge at State Route 684 crossing of Taylor Run, approximately 80 feet northwest of Chesapeake & Ohio Railroad bridge over State Route 684 and Grassy Run. Elevation 1510.76

Glossary of Terms

backwater. High water caused by downstream obstruction or restriction, or by high stage on an intersecting stream.

BM. Benchmark of established elevation.

cfs. Cubic feet per second - a unit of discharge that is equal to the flow of one cubic foot per second past a given point.

cross section. Shape and dimensions of a channel and valley perpendicular to the line of flow.

elev.-bridge deck. Elevation of a roadway across a bridge or culvert.

elev.-low beam. Elevation of lowest structural "beam" that limits the height of the bridge opening; or may indicate the top of a culvert opening.

elev.-low road. Elevation of low point on a roadway approaching or crossing a bridge or culvert - shown only if lower than elev.-bridge deck at a particular road section.

flood. An overflow of lands not normally covered by water: a temporary increase in streamflow or stage; or the discharge causing the overflow or temporary increase.

flood frequency. An expression of how often a flood of given magnitude can be expected.

Examples:

10-year frequency flood. The flood which can be expected or exceeded on an average once in 10 years; and which would have a 10 percent chance of being equalled or exceeded in any given year.

100-year frequency flood. ....one percent chance ...in any given year.

flood peak or peak discharge. Highest discharge attained during a flood.

flood plain or flood-prone area. Lands adjoining a stream (or other body of water) which has been or may be covered with water.

flood profile or profile. A plotted or imaginary line defining the highest water surface elevations along a stream during a particular flood.

flood prone area. See flood plain.

flood routing. Computation of the changes in the rise and fall in streamflow as a flood moves downstream. The results provide hydrographs of discharge versus time at given points on the stream.

frequency-discharge curve. A plotted line showing the recurrent interval (or flood frequency) of discharges at a stream gage, surveyed cross section, or other station along stream. (Used with a stage-discharge curve to determine the high water elevations resulting from selected flood discharges at that station on the stream.)

hydrograph. A curve showing the rise and fall of flood discharge with respect to time at a specific station on the stream.

land use. Classification of type of vegetation or other surface cover conditions on a watershed - used (with a similar classification of soils) to indicate the rate and volume of flood runoff.

NGVD. National Geodetic Vertical Datum of 1929, same as mean sea level.

peak discharge or flood peak. The highest rate of runoff (discharge) attained during a flood.

profile. See flood profile.

runoff. That portion of the total storm rainfall flowing across the ground or other surface and contributing to the flood discharge.

stage-discharge curve. A plotted curve showing elevations resulting from a range of discharges at a surveyed cross section, stream gage, or other point on a stream.

TBM. Temporary benchmark.

watershed. A drainage area which collects and transmits runoff to the outlet of the drainage basin.

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5. A Perspective on Flood Plain Regulations for Flood Plain Management, Department of the Army, Office of the Chief of Engineers, Washington, D. C., June 1976.

6. Flood-Proofing Regulations, Office of the Chief of Engineers, U. S. Army, Washington, D. C., June 1972.

7. WSP2 Computer Program, Soil Conservation Service Technical Release No. 61, May 1976.

8. Computer Program For Project Formulation Hydrology, Soil Conservation Service Technical Release No. 20, May 1965.

9. Flood Flow Frequency, Bulletin 17A, U. S. Water Resources Council, Washington, D. C., revised June 1977.

10. Floodway Determination Computer Program, Soil Conservation Service Technical Release No. 64, June 1978.

11. Topographic maps; 7.5 minute series; scale, 1:24000; U.S. Geological Survey, Washington, D. C.: Craigsville, VA, 1967; Augusta Springs, VA, 1967.

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